

CLAIMS:

1. A fiber laser using as a gain medium an optical fiber that has a core or a cladding doped with a rare-earth element
5 having a laser transition level, said fiber laser being characterized in that:

said optical fiber is doped with at least thulium; and
said fiber laser employs 1.2 μm band light or a pumping
source for exciting the thulium from the lowest energy level
10 $^3\text{H}_6$ to $^3\text{H}_5$ excitation level as a pumping source, and operates
at least at 2.3 μm band.

2. The fiber laser as claimed in claim 1, wherein said
optical fiber doped with the thulium is a non-silica based
15 fiber that uses glass having a nonradiative relaxation rate
which is caused by multi-phonon relaxation and is less than
a nonradiative relaxation rate of silica glass as host glass
of the optical fiber.

20 3. The fiber laser as claimed in claim 2, where said
non-silica based fiber is one of a fluoride fiber, tellurite
glass fiber, bismuth based glass fiber, fluorophosphate
glass fiber, chalcogenide glass fiber, and germanate
hydroxide glass fiber.

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4. The fiber laser as claimed in any one of claims 1-3,
using laser transition at least from $^3\text{F}_4$ to $^3\text{H}_5$ level.

5. The fiber laser as claimed in any one of claims 1-3, operating in both 2.3 μm band and 1.8 μm band wavelength regions.

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6. The fiber laser as claimed in any one of claims 1-3, using laser transition not only from $^3\text{F}_4$ to $^3\text{H}_5$ level, but also from $^3\text{H}_4$ to $^3\text{H}_5$ level.

10 7. A fiber laser using as a gain medium an optical fiber that has a core or a cladding doped with a rare-earth element having a laser transition level, said fiber laser having said optical fiber doped at least with thulium, and operating at 2.3 μm band, said fiber laser being characterized in
15 that:

said fiber laser uses 0.67 μm band or 0.8 μm band light as a pumping source, and said optical fiber doped at least with the thulium is a non-silica based fiber which uses, as host glass of said optical fiber, glass having a
20 nonradiative relaxation rate which is caused by multi-phonon relaxation and is lower than a nonradiative relaxation rate of silica glass.

8. The fiber laser as claimed in claim 7, wherein

25 said optical fiber doped at least with the thulium is one of a tellurite glass fiber, bismuth based glass fiber, fluorophosphate glass fiber, chalcogenide glass fiber, and

germanate hydroxide glass fiber.

9. The fiber laser as claimed in claim 7 or 8, using laser transition from 3F_4 to 3H_5 level.

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10. A spontaneous emission source using as a gain medium an optical fiber that has a core or a cladding doped with a rare-earth element having a laser transition level, said spontaneous emission source being characterized in that:

10 said optical fiber is doped with at least thulium; and
said spontaneous emission source employs 1.2 μ m band light or a pumping source for exciting the thulium from the lowest energy level 3H_6 to 3H_5 excitation level as a pumping source, and operates at least at 2.3 μ m band.

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11. The spontaneous emission source as claimed in claim 10, wherein said optical fiber doped with the thulium is a non-silica based fiber which uses, as host glass of said optical fiber, glass having a nonradiative relaxation rate
20 which is caused by multi-phonon relaxation and is lower than a nonradiative relaxation rate of silica glass.

12. The spontaneous emission source as claimed in claim 11, wherein said non-silica based fiber is one of a fluoride
25 fiber, tellurite glass fiber, bismuth based glass fiber, fluorophosphate glass fiber, chalcogenide glass fiber, and germanate hydroxide glass fiber.

13. The spontaneous emission source as claimed in any one of claims 10-12, using laser transition at least from 3F_4 to 3H_5 level.

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14. The spontaneous emission source as claimed in any one of claims 10-12, operating in both 2.3 μm band and 1.8 μm band wavelength regions.

10 15. The spontaneous emission source as claimed in any one of claims 10-12, using laser transition not only from 3F_4 to 3H_5 level, but also from 3H_4 to 3H_5 level.

15 16. A spontaneous emission source using as a gain medium an optical fiber that has a core or a cladding doped with a rare-earth element having a laser transition level, said spontaneous emission source having said optical fiber doped at least with thulium, and operating at 2.3 μm band, said spontaneous emission source being characterized in that:

20 said spontaneous emission source uses 0.67 μm band or 0.8 μm band light as a pumping source, and said optical fiber doped at least with the thulium is a non-silica based fiber which uses, as host glass of said optical fiber, glass having a nonradiative relaxation rate which is caused by
25 multi-phonon relaxation and is lower than a nonradiative relaxation rate of silica glass.

17. The spontaneous emission source as claimed in claim 16, wherein said optical fiber doped at least with the thulium is one of a tellurite glass fiber, bismuth based glass fiber, fluorophosphate glass fiber, chalcogenide glass fiber, and
5 germanate hydroxide glass fiber.

18. The spontaneous emission source as claimed in claim 17, using laser transition from 3F_4 to 3H_5 level.

10 19. An optical fiber amplifier using as a gain medium an optical fiber that has a core or a cladding doped with a rare-earth element having a laser transition level, said optical fiber amplifier being characterized in that:

said optical fiber is doped with at least thulium; and
15 said optical fiber amplifier employs 1.2 μm band light or a pumping source for exciting the thulium from the lowest energy level 3H_6 to 3H_5 excitation level as a pumping source, and operates at least at 2.3 μm band.

20 20. The optical fiber amplifier as claimed in claim 19, wherein said optical fiber doped with the thulium is a non-silica based fiber that uses glass having a nonradiative relaxation rate which is caused by multi-phonon relaxation and is less than a nonradiative relaxation rate of silica
25 glass as host glass of the optical fiber.

21. The optical fiber amplifier as claimed in claim 20,

where said non-silica based fiber is one of a fluoride fiber, tellurite glass fiber, bismuth based glass fiber, fluorophosphate glass fiber, chalcogenide glass fiber, and germanate hydroxide glass fiber.

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22. The optical fiber amplifier as claimed in any one of claims 19-21, using laser transition at least from 3F_4 to 3H_5 level.

10 23. The optical fiber amplifier as claimed in any one of claims 19-21, operating in both 2.3 μm band and 1.8 μm band wavelength regions.

24. The optical fiber amplifier as claimed in any one of
15 claims 19-21, using laser transition not only from 3F_4 to 3H_5 level, but also from 3H_4 to 3H_5 level.

25. An optical fiber amplifier using as a gain medium an optical fiber that has a core or a cladding doped with a
20 rare-earth element having a laser transition level, said optical fiber amplifier having said optical fiber doped at least with thulium, and operating at 2.3 μm band, said optical fiber amplifier being characterized in that:

said optical fiber amplifier uses 0.67 μm band or 0.8
25 μm band light as a pumping source, and said optical fiber doped at least with the thulium is a non-silica based fiber which uses, as host glass of said optical fiber, glass having

a nonradiative relaxation rate which is caused by multi-phonon relaxation and is lower than a nonradiative relaxation rate of silica glass.

- 5 26. The optical fiber amplifier as claimed in claim 25, wherein said optical fiber doped at least with the thulium is one of a tellurite glass fiber, bismuth based glass fiber, fluorophosphate glass fiber, chalcogenide glass fiber, and germanate hydroxide glass fiber.

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27. The optical fiber amplifier as claimed in claim 25 or 26, using laser transition from 3F_4 to 3H_5 level.